Space Weather Technical Forecast

Issued on Tuesday, 05 April 2022 at 13:37 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Minor/Moderate G1/G2 geomagnetic storm likely day 2 (6th April) from a centre-disc filament eruption on 03 April with a slight chance of a G3 Strong storm.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low over the past 24 hours with several minor C class flares.
There are currently six sunspots on the visible disc, with four of these numbered, two unnumbered. The largest region on the disc is AR2978, has retained a similar Ehi/Beta classification to recent days, with minor intermediate spot proliferation. To its immediate south, AR2981 has remained stable, finishing the 24 hours as a Cao/Beta. The remaining two numbered regions, AR2983 and 2985 in the eastern hemisphere, as well as the two un-numbered regions are all unipolar, stable and unremarkable.
At 04/2113 UTC a filament eruption occurred in the south central disc, with this event visible in images such as AIA304 as well as Cerro Tololo H-Alpha amongst others. This event was tied to a C2.7 flare, and given its central location may well carry an Earth-directed component. Provisional analysis suggests a possible impact on the 9th April, with updates to follow once a further analysis is completed. No other Earth-directed CMEs were apparent in imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, has slowly declined probably due to waning affects from CH70, ending the period around 440 km/s. The solar wind density was within its typical average range of mid-single figures ppcc, while the IMF remained weak below 7nT. The north-south component varied between -5 and +5nT, although this was often aligned southward to some degree. The phi angle was mainly negative (towards the sun).
The net result of the above solar wind was Quiet geomagnetic conditions (Kp1-2) with one Unsettled interval (Kp3) between 04/1800-2100 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10MeV) measured at GOES-16 showed a continuing gradual relaxation towards Background levels, having reached S1/Minor Storm on 02 April, in the wake of an M-class flare from the northwest limb.
The high energy (greater than 2MeV) electron flux as observed by GOES-16 at GEO showed an increased-amplitude diurnal oscillation between Normal Background and High flux, peaking at 3920 pfu at 03/1645 UTC. The 24-hour integrated fluence showed a relatively flat trend throughout, just below Active fluence and with 8.64e7 integrated pfu recorded at 05/0001 UTC.

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Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity should be predominantly Low, with relatively fewer and less complex active regions on the visible disc than of late.

Solar Wind / Geomagnetic Activity: The current coronal hole high speed stream is the only one in the forecast, and an exit to a slow wind regime is expected for day 1 (5th April), with geomagnetic activity then largely Quiet in the absence of transients.
There is one confirmed CME in the forecast at present, that from the 03/1500 UTC filament eruption. This is due to arrive around 06/1800 UTC, with the Likely result of a Minor or Moderate G1/G2 geomagnetic storm intervals and a Slight Chance of a G3 Strong geomagnetic storm, perhaps continuing into day 3 (7th April).
In addition to this confirmed CME, a second centre-disc filament eruption observed to peak around 04/2100 UTC. Provisional analysis is forecast to possibly give Earth a weak impact on the 9th, with updates to follow as and when more imagery becomes available.

Energetic Particles / Solar Radiation: The risk of further solar radiation storms should now slowly reduce as last week's highly active northwestern sunspot regions rotate further onto the far side. The residual risk from current front side groups is much lower given stable appearance. The high energy (greater than 2 MeV) electron flux may show a slight day-on-day increase in the short term, in the wake of recent fast wind influence. The chances of Active fluence are marginal through to day 2 (6th April), but again perhaps slightly more likely than not to occur. Flux levels may then be attenuated by the 03/1600 UTC CME arrival, which is currently expected to arrive at Earth on day 2 (6th April). Any recovery in fluence following this will probably be insufficient to breach Active.

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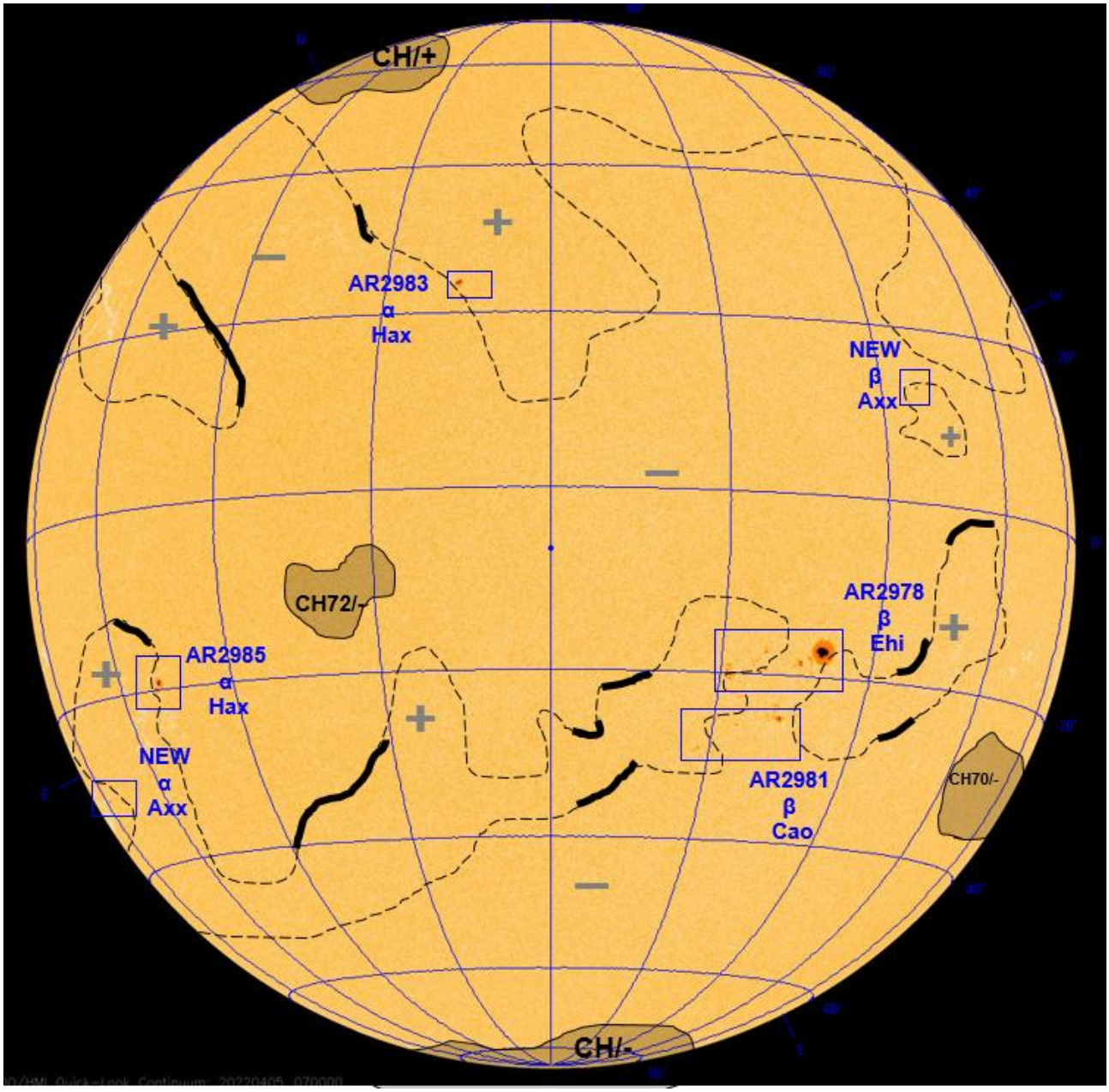
Figure 1. Solar Analysis Valid 05/0700UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

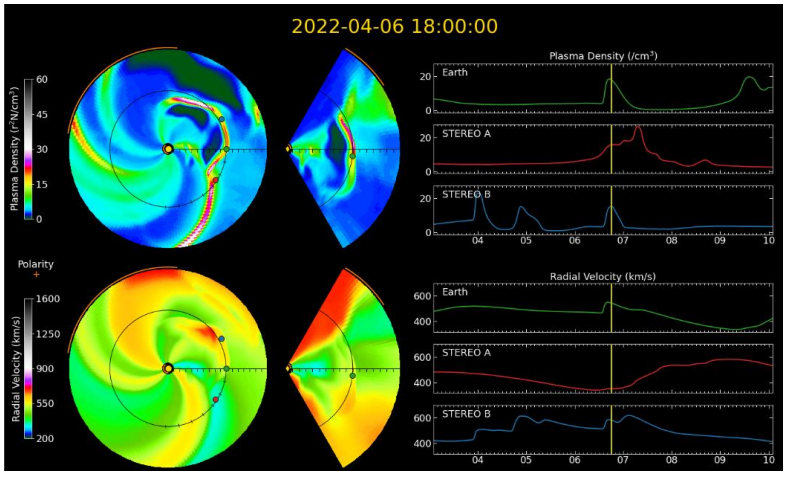
The current connection to a negative polarity high speed stream is the only likely coronal hole influence in the four-day period. Solar winds have been easing slowly in the past 24 hours but remains erratic, with frequent minor resurgences perhaps surprising given the apparently minor CH71 and CH70. The erratic traces may be reflective of peripheral influence of these features and a weak connection, however a decline to a slow solar wind environment is expected on day 1 (5th April) to leave mainly Quiet conditions on day 1 into day 2 (5th/6th April).
There is one confirmed CME in the current forecast. The 03/1500 UTC filament eruption formed a full halo in available coronagraph imagery, and can be expected to arrive within the UTC day of day 2 (6th April), with a Chance of effects ongoing into Thursday 07 April. G1/G2 Minor or Moderate storms are Likely with a slight chance of a G3 Strong storm on day 2 (6th). By day 4 (8th April) geomagnetic activity is likely to have returned to Quiet to Unsettled.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	70	30	1
Strong	G3	No	1	5	2	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
03/2114	Full	Filament eruption	Centre-SW quadrant	595 km/s	06/1800UTC	Onset after 06/1200UTC

Figure 2: MOSWOC Enlil shows the CME from the 3rd April arriving around 06/1800UTC.



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Radio Blackouts - X-Ray Flares:

The sun now appears to show an overall waning in X-ray activity, particularly given the departure from the Earth-facing side of Ex-AR2975 and to a lesser degree Ex-AR2976. This has left a disc populated by quiet unipolar groups and the large, but quiet and fading AR2978 and AR2981 near centre-disc.

There are some bright flux regions hinted at in STEREO A EUVI 195 imagery about to approach the eastern solar horizon. These may offset the departing regions to some degree, however these will be analysed in due course and do not yet feature in the forecast.

Overall, the chances of significant X-ray flares are much-reduced. M-class flares are rated at a daily Slight Chance throughout, largely the result of the raw potential of AR2978, although this has not been borne out in its activity, and the probabilities may yet be reduced further.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	20	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is now well below the S1/Minor Storm threshold but remains slightly above resting background levels. This is expected to now very soon decline to its background state.

The source of all the recent S1 and near-S1 level enhancements (Ex-AR2975) rotated around the northwest limb late on Sunday 2nd April, and as such its contribution to the risk of further such events should lessen. The residual risk of S1 should then be inherited by the westward advance of the large but relatively subdued AR2978 and AR2981, perhaps offering a lower ongoing risk from day 3 (7th April).

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	15	10	5	5
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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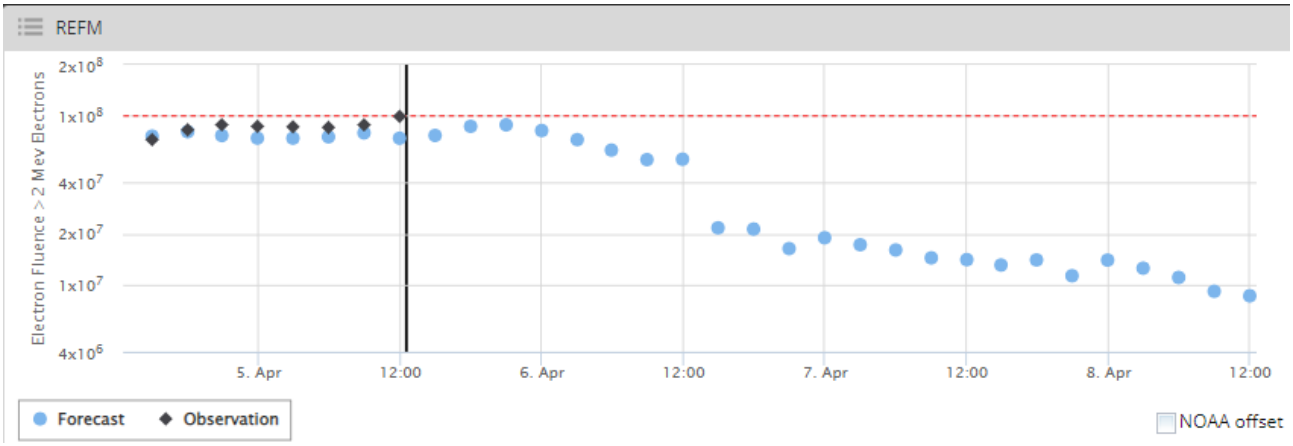
High Energy Electrons Event (≥ 2MeV):
High energy electron flux showed a slight diurnal increase in its oscillation over the UTC day of Monday 04 April, although the character was a little erratic in tandem with the behaviour of the solar wind. Flux levels have slowly increased. As with recent forecasts, 24-hour integrated fluence may just exceed Active until the arrival of the 03/1500 UTC CME around 06/1800 UTC. It is felt that current flux levels may not be repeated in the less supportive solar wind environment that should surround these possible transients, and the overall risk of Active therefore shows a step-wise fall after day 2 (6th).

GEO Electron Environment	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	80	60	20	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3: MOSWOC REF Model shows integrated electron fluence levels close to the 1e8 Active threshold for the next 24 hours or so.



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